Claims

[c1] A method of operating an electron beam physical vapor deposition coating apparatus (10), the method comprising the steps of:

performing a first coating operation during which:

at least a first article (20) is placed in a coating chamber (14) in which a subatmospheric pressure is maintained; and

an electron beam gun (30) is operated to project an electron beam (32) into the coating chamber (14) and onto a ceramic material (24), the electron beam (32) heating, melting and evaporating the ceramic material (24) to deposit a ceramic coating on the first article (20);

wherein combined heat transfer from the coating chamber (14) and the ceramic material (24) to the first article (20) occurs at a first heat transfer rate while the first article (20) is within the coating chamber (14), so that a surface temperature of the first article (20) does not exceed about 1000 ° C during deposition of the ceramic coating on the first article (20); and

subsequently performing a second coating operation during which:

at least a second article (20) is placed in the coating chamber (14) in which a subatmospheric pressure is maintained; and

the electron beam gun (30) is operated to project the electron beam (32) into the coating chamber (14) and onto the ceramic material (24) to heat, melt and evaporate the ceramic material (24) and deposit a ceramic coating on the second article (20);

wherein combined heat transfer from the coating chamber (14) and the ceramic material (24) to the second article (20) occurs at a second heat transfer rate that is lower than the first heat transfer rate while the second article (20) is within the coating chamber (14), so that a surface temperature of the second article (20) does not exceed about 1000 ° C during deposition of the ceramic coating on the second article (20).

[c2] A method according to claim 1, further comprising the step of preheating the first and second articles (20) prior to being placed in the coating chamber (14).

[c3] A method according to claim 2, wherein the first and second articles (20) are preheated to a temperature higher than 1000 ° C.

[c4] A method according to claim 2, wherein the first and second articles (20) are preheated to a temperature of about 1100 ° C.

[c5] A method according to claim 1, wherein the first and second heat transfer rates are achieved at least in part by operating the electron beam gun (30) at a higher power during the first coating operation than during the second coating operation.

[c6] A method according to claim 1, wherein the first and second heat transfer rates are achieved at least in part by operating the electron beam gun (30) to project the electron beam (32) onto a larger surface area during the first coating operation than during the second coating operation.

[c7] A method according to claim 1, wherein the first and second heat transfer rates are achieved at least in part by operating a heat-generating means (40) within the coating chamber (14) during the first coating operation, and reducing the heat output of the heat-generating means (40) during the second coating operation.

[c8] A method according to claim 1, wherein the first and second heat transfer rates are achieved at least in part by positioning at least one heat-reflecting means (40,42) a first distance from the first article (20) during the first coating operation, and repositioning the heat-reflecting means (40,42) to be a second distance from the second article (20) during the second coating operation, the second distance being greater than the first distance.

[c9] A method according to claim 1, wherein the first and second heat transfer rates are achieved at least in part by at least one heat-reflecting means (40,42) located in the coating chamber (14) and means (44) for cooling the heat-reflecting means (40,42), the cooling means (44) maintaining the heat-reflecting means (40,42) at a first reflection temperature during the first coating operation and at a second reflection temperature during the second coating operation, the first reflection temperature being higher than the second reflection temperature.

[c10] A method according to claim 1, wherein the first and second surface

temperatures of the first and second articles (20) are between about 925 ° C and about 1000 ° C.

[c11] A method according to claim 1, wherein the coating material (24) is yttria-stabilized zirconia.

[c12] A method according to claim 1, wherein the coating material (24) is zirconia stabilized by about seven weight percent yttria.

[c13] A method according to claim 1, wherein the first and second articles (20) are gas turbine engine components.

[c14] A method of operating an electron beam physical vapor deposition coating apparatus (10), the method comprising a plurality of successive coating operations by which thermal barrier coatings are deposited on gas turbine engine components (20) during each of the coating operations, each of the coating operations comprising the steps of:
preheating the components (20) to a preheat temperature;
placing the components (20) in a coating chamber (14) in which a subatmospheric pressure is maintained; and
operating an electron beam gun (30) to project an electron beam (32) into the coating chamber (14) and onto at least one ingot (24) of yttria-stabilized zirconia, the electron beam (32) heating, melting and evaporating the ingot (24) to deposit the thermal barrier coatings on the components (20);
wherein the electron beam (32) is operated so that a molten pool (36) of yttria-stabilized zirconia is continuously maintained during the successive coating operations and the temperatures of the ingot (24) and the coating chamber (14) continuously rise during the successive coating operations;
wherein combined heat transfer from the coating chamber (14) and the ingot (24) to the components (20) occurs at a first heat transfer rate during a first of the coating operations, so that surface temperatures of the components (20) are between about 925 ° C and about 1000 ° C during deposition of the thermal barrier coatings on the components (20) during the first coating operation; and
wherein combined heat transfer from the coating chamber (14) and the ingot (24) to the components (20) occurs at a second heat transfer rate that is lower

than the first heat transfer rate during a last of the coating operations, so that surface temperatures of the components (20) are between about 925 ° C and about 1000 ° C during deposition of the thermal barrier coatings on the components (20) during the last coating operation.

[c15] A method according to claim 14, wherein the preheat temperatures during the first and last coating operations are higher than 1000 ° C .

[c16] A method according to claim 14, wherein the first and second heat transfer rates are achieved at least in part by operating the electron beam gun (30) at a higher power during the first coating operation than during the last coating operation.

[c17] A method according to claim 14, wherein the first and second heat transfer rates are achieved at least in part by operating the electron beam gun (30) to project the electron beam (32) over a larger surface area of the ingot (24) during the first coating operation than during the last coating operation.

[c18] A method according to claim 14, wherein the first and second heat transfer rates are achieved at least in part by operating a heat-generating means (40) within the coating chamber (14) during the first coating operation, and reducing the heat output of the heat-generating means (40) during the last coating operation.

[c19] A method according to claim 14, wherein the first and second heat transfer rates are achieved at least in part by positioning at least one heat-reflecting means (40,42) a first distance from the components (20) during the first coating operation, and repositioning the heat-reflecting means (40,42) to be a second distance from the components (20) during the last coating operation, the second distance being greater than the first distance.

[c20] A method according to claim 14, wherein the first and second heat transfer rates are achieved at least in part by at least one heat-reflecting means (40,42) located in the coating chamber (14) and means (44) for cooling the heat-reflecting means (40,42), the cooling means (44) maintaining the heat-reflecting means (40,42) at a first reflection temperature during the first coating

operation and at a second reflection temperature during the last coating operation, the first reflection temperature being higher than the second reflection temperature.